US009468943B2

(12) United States Patent
Arik et al.

(10) Patent No.: US 9,468,943 B2
(45) Date of Patent: Oct. 18, 2016

(54) **SYSTEM AND METHOD FOR MOUNTING SYNTHETIC JETS**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 189 days.

(21) Appl. No.: **14/187,519**

(22) Filed: **Feb. 24, 2014**

(65) **Prior Publication Data**

US 2014/0166777 A1 Jun. 19, 2014

Related U.S. Application Data

(60) Division of application No. 13/253,356, filed on Oct. 5, 2011, now Pat. No. 8,827,179, which is a continuation of application No. 12/198,301, filed on Aug. 26, 2008, now Pat. No. 8,083,157.

(51) **Int. Cl.**

B05B 1/08	(2006.01)
B05B 17/06	(2006.01)
F04B 43/04	(2006.01)
F04B 17/00	(2006.01)
F23D 14/48	(2006.01)

(52) **U.S. Cl.**
CPC ***B05B 17/0615*** (2013.01); ***F04B 17/003*** (2013.01); ***F04B 43/046*** (2013.01); ***F23D 14/48*** (2013.01); *F23D 2900/14482* (2013.01)

(58) **Field of Classification Search**
CPC F04B 17/003; F04B 43/046; F23D 14/48; F23D 2900/14482; B05B 17/0615
USPC 239/102.1, 102.2, 4, 600; 128/200.16, 128/200.22; 417/322
See application file for complete search history.

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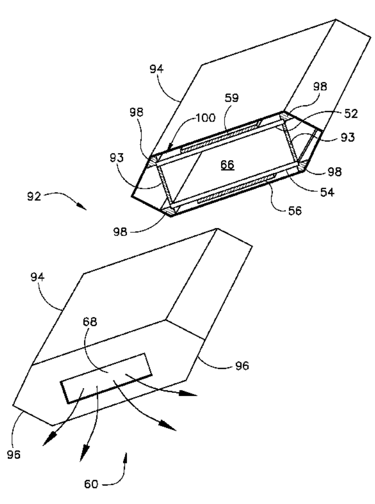
(57) **ABSTRACT**

A system and method for the packaging of a synthetic jet actuator is disclosed. A synthetic jet actuator is provided that includes a first plate, a second plate spaced apart from the first plate and arranged parallelly thereto, and a housing positioned about the first and second plates and defining a chamber. The housing includes at least one orifice therein such that the chamber is in fluid communication with an external environment. The synthetic jet actuator also includes a mounting mechanism configured to mount the first and second plates within the housing in a suspended arrangement and an actuator element coupled to at least one of the first and second plates to selectively cause deflection thereof, thereby changing a volume within the chamber so that a series of fluid vortices are generated and projected to the external environment out from the at least one orifice of the housing.

17 Claims, 3 Drawing Sheets



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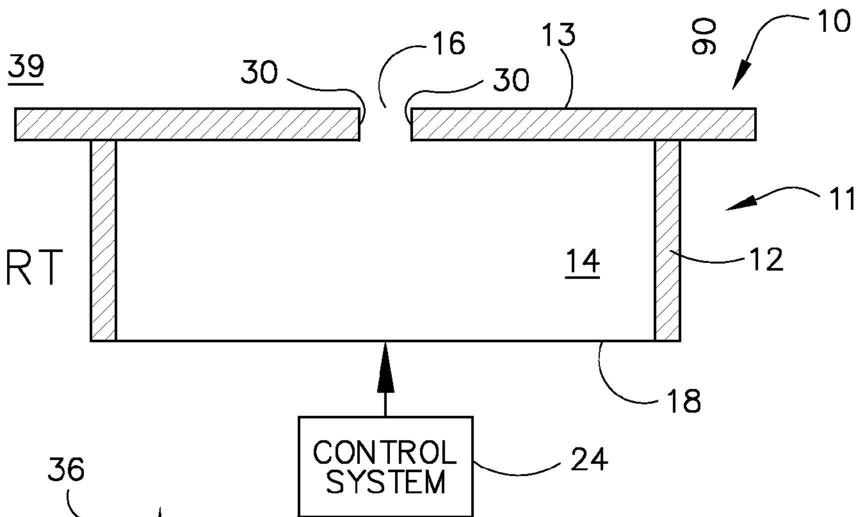


FIG. 1
PRIOR ART

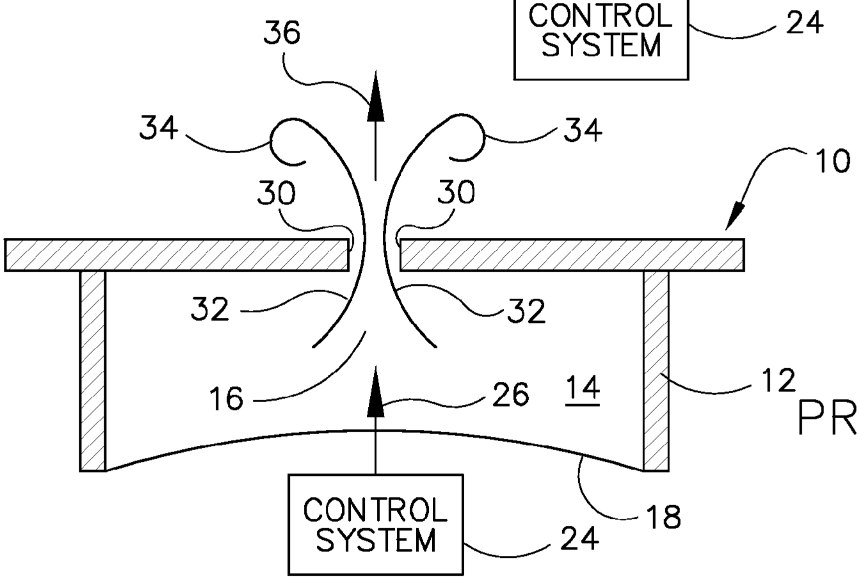


FIG. 2
PRIOR ART

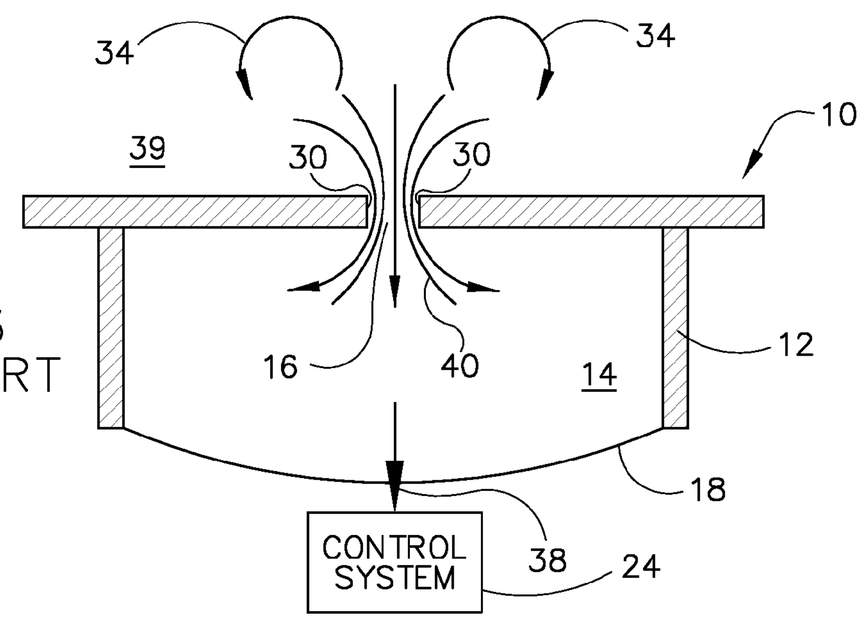


FIG. 3
PRIOR ART

FIG. 5

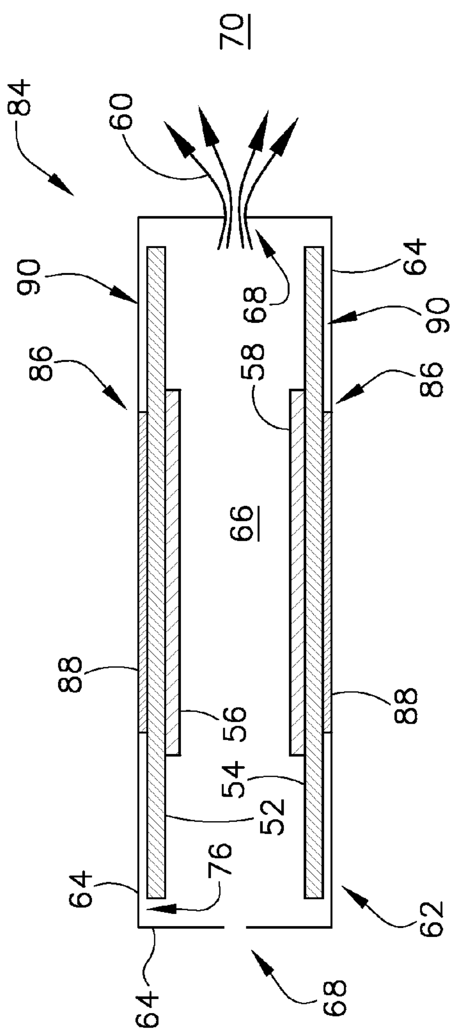


FIG. 4

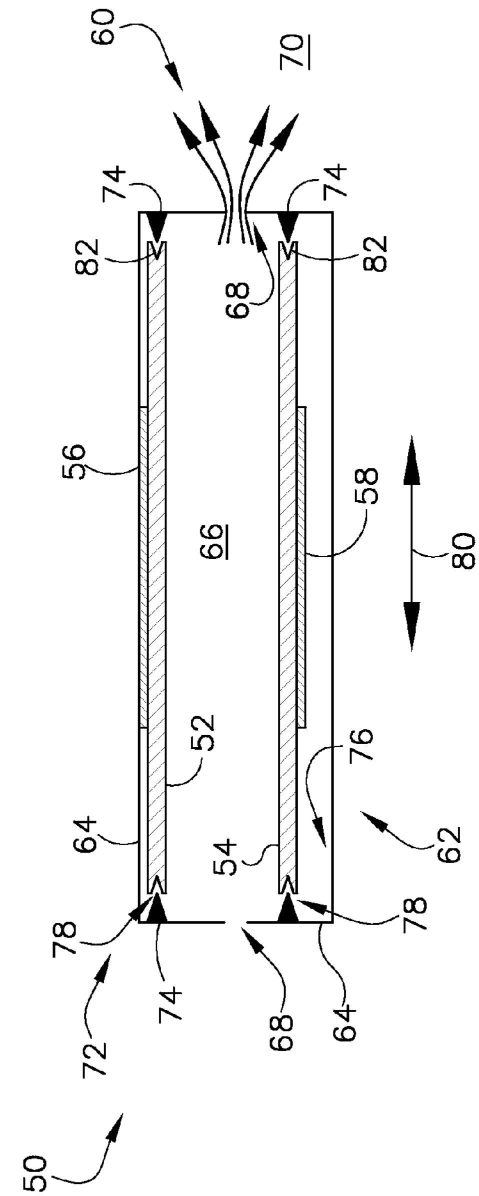
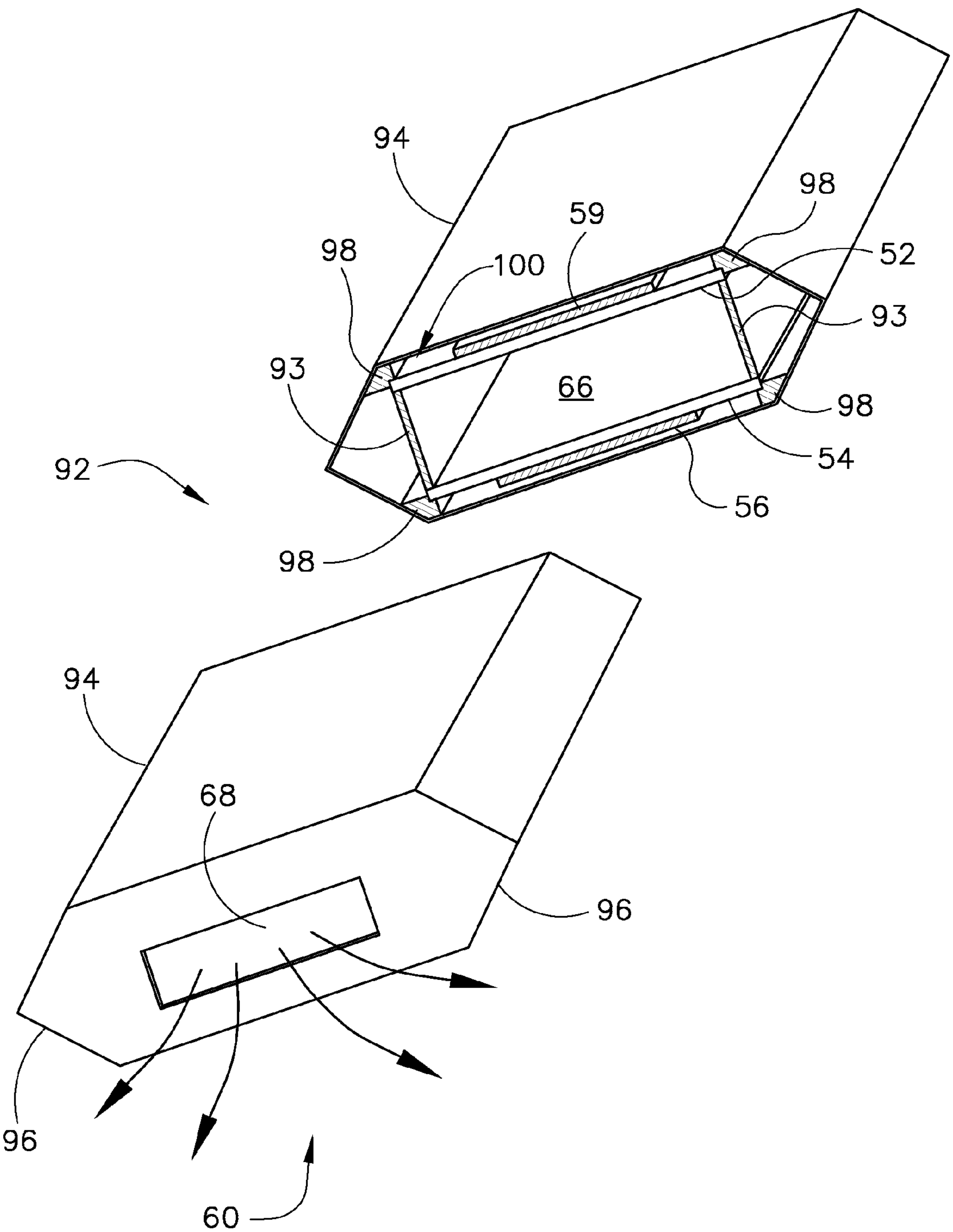


FIG. 6



SYSTEM AND METHOD FOR MOUNTING SYNTHETIC JETS

CROSS-REFERENCE TO RELATED APPLICATION

The present application is a divisional of and claims priority to U.S. patent application Ser. No. 13/253,356, filed Oct. 5, 2011, which is a continuation of and claims priority to U.S. patent application Ser. No. 12/198,301, filed Aug. 26, 2008 and issued as U.S. Pat. No. 8,083,157, the disclosure of which is incorporated herein.

BACKGROUND OF THE INVENTION

Embodiments of the invention relate generally to synthetic jet actuators and, more particularly, to the packaging of synthetic jet actuators.

Synthetic jet actuators are a widely-used technology that generates a synthetic jet of fluid to influence the flow of that fluid over a surface. A typical synthetic jet actuator comprises a housing defining an internal chamber. An orifice is present in a wall of the housing. The actuator further includes a mechanism in or about the housing for periodically changing the volume within the internal chamber so that a series of fluid vortices are generated and projected in an external environment out from the orifice of the housing. Examples of volume changing mechanisms may include, for example, a piston positioned in the jet housing to move fluid in and out of the orifice during reciprocation of the piston or a flexible diaphragm as a wall of the housing. The flexible diaphragm is typically actuated by a piezoelectric actuator or other appropriate means.

Typically, a control system is used to create time-harmonic motion of the volume changing mechanism. As the mechanism decreases the chamber volume, fluid is ejected from the chamber through the orifice. As the fluid passes through the orifice, sharp edges of the orifice separate the flow to create vortex sheets that roll up into vortices. These vortices move away from the edges of the orifice under their own self-induced velocity. As the mechanism increases the chamber volume, ambient fluid is drawn into the chamber from large distances from the orifice. Since the vortices have already moved away from the edges of the orifice, they are not affected by the ambient fluid entering into the chamber. As the vortices travel away from the orifice, they synthesize a jet of fluid, i.e., a “synthetic jet.”

Due to their inclusion of flexible diaphragms piezoelectric actuator elements, it is recognized that synthetic jet actuators are fragile mechanisms. As synthetic jet actuators can be subjected to a range of environment conditions during use, this can lead to occurrences of pre-mature failure and to the need for replacement of the synthetic jet actuators. Such replacement of the synthetic jet actuators can be time consuming and, in some cases, can also necessitate shutdown of the system or components to which the synthetic jet actuators are designed to provide cooling to. It would thus be beneficial for the synthetic jet actuator be protected from the surrounding environment such that the synthetic jet actuator may be protected from temperature extremes, moisture, and physical impact from surrounding components.

Accordingly, there is a need for a system and method for packaging synthetic jet actuators so as to provide protection from environmental conditions. There is a further need for such a system to have minimal impact on the operation and performance of the synthetic jet actuators.

BRIEF DESCRIPTION OF THE INVENTION

Embodiments of the invention overcome the aforementioned drawbacks by providing a system and method for packaging synthetic jet actuators. Synthetic jet plates and actuator elements of the synthetic jet actuator are mounted within an outer housing in a suspended arrangement such that the housing has a minimal impact on the operation and performance of the synthetic jet actuator.

In accordance with one aspect of the invention, a synthetic jet actuator includes a first plate, a second plate spaced apart from the first plate and arranged parallelly thereto, and a housing positioned about the first and second plates and defining a chamber, the housing having at least one orifice therein such that the chamber is in fluid communication with an external environment. The synthetic jet actuator also includes a mounting mechanism configured to mount the first and second plates within the housing in a suspended arrangement and an actuator element coupled to at least one of the first and second plates to selectively cause deflection thereof, thereby changing a volume within the chamber so that a series of fluid vortices are generated and projected to the external environment out from the at least one orifice of the housing.

In accordance with another aspect of the invention, a method of manufacturing a synthetic jet actuator includes providing an outer housing having a plurality of walls defining a chamber and having an orifice formed in at least one of the plurality of walls and positioning a pair of synthetic jet plates within the outer housing and on opposite ends thereof. The method also includes attaching the pair of synthetic jet plates to the outer housing such that the pair of synthetic jet plates are spaced apart from each of the plurality of walls.

In accordance with yet another aspect of the invention, a synthetic jet actuator includes an outer housing defining a chamber and having at least one opening formed therein and a pair of synthetic jet plates positioned within the outer housing and on opposing sides thereof. The synthetic jet actuator also includes a mounting device configured to affix the pair of synthetic jet plates to the outer housing such that the pair of synthetic jet plates are inwardly spaced from the outer housing so as not to be in contact therewith and at least one actuator element coupled to the pair of synthetic jet plates to selectively change a volume within the chamber so that a series of fluid vortices are generated and projected to an external environment out from the at least one opening in the outer housing.

These and other advantages and features will be more readily understood from the following detailed description of preferred embodiments of the invention that is provided in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The drawings illustrate embodiments presently contemplated for carrying out the invention.

In the drawings:

FIG. **1** is a cross-section of a prior art zero net mass flux synthetic jet actuator with a control system.

FIG. **2** is a cross-section of the synthetic jet actuator of FIG. **1** depicting the jet as the control system causes the diaphragm to travel inward, toward the orifice.

FIG. **3** is a cross-section of the synthetic jet actuator of FIG. **1** depicting the jet as the control system causes the diaphragm to travel outward, away from the orifice.

FIG. **4** is a schematic cross-sectional side view of a synthetic jet actuator according to an embodiment of the invention.

FIG. **5** is a schematic cross-sectional side view of a synthetic jet actuator according to another embodiment of the invention.

FIG. **6** is an exploded perspective view of a synthetic jet actuator according to another embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The present invention provides for a system and method of providing a packaged synthetic jet actuator. The packaged synthetic jet actuator includes an outer housing that surrounds synthetic jet plates and actuator elements, which are mounted to the housing in a suspended arrangement.

Referring to FIGS. **1-3**, a synthetic jet actuator **10** as known in the art, and the operation thereof, is shown for purposes of describing the general operation of a synthetic jet actuator. The synthetic jet actuator **10** includes a housing **11** defining and enclosing an internal chamber **14**. The housing **11** and chamber **14** can take virtually any geometric configuration, but for purposes of discussion and understanding, the housing **11** is shown in cross-section in FIG. **1** to have a rigid side wall **12**, a rigid front wall **13**, and a rear diaphragm **18** that is flexible to an extent to permit movement of the diaphragm **18** inwardly and outwardly relative to the chamber **14**. The front wall **13** has an orifice **16** of any geometric shape. The orifice diametrically opposes the rear diaphragm **18** and connects the internal chamber **14** to an external environment having ambient fluid **39**.

The flexible diaphragm **18** may be controlled to move by any suitable control system **24**. For example, the diaphragm **18** may be equipped with a metal layer, and a metal electrode may be disposed adjacent to but spaced from the metal layer so that the diaphragm **18** can be moved via an electrical bias imposed between the electrode and the metal layer. Moreover, the generation of the electrical bias can be controlled by any suitable device, for example but not limited to, a computer, logic processor, or signal generator. The control system **24** can cause the diaphragm **18** to move periodically, or modulate in time-harmonic motion, and force fluid in and out of the orifice **16**. Alternatively, a piezoelectric actuator could be attached to the diaphragm **18**. The control system would, in that case, cause the piezoelectric actuator to vibrate and thereby move the diaphragm **18** in time-harmonic motion.

The operation of the synthetic jet actuator **10** is described with reference to FIGS. **2** and **3**. FIG. **2** depicts the synthetic jet actuator **10** as the diaphragm **18** is controlled to move inward into the chamber **14**, as depicted by arrow **26**. The chamber **14** has its volume decreased and fluid is ejected through the orifice **16**. As the fluid exits the chamber **14** through the orifice **16**, the flow separates at sharp orifice edges **30** and creates vortex sheets **32** which roll into vortices **34** and begin to move away from the orifice edges **30** in the direction indicated by arrow **36**.

FIG. **3** depicts the synthetic jet actuator **10** as the diaphragm **18** is controlled to move outward with respect to the chamber **14**, as depicted by arrow **38**. The chamber **14** has its volume increased and ambient fluid **39** rushes into the chamber **14** as depicted by the set of arrows **40**. The diaphragm **18** is controlled by the control system **24** so that when the diaphragm **18** moves away from the chamber **14**, the vortices **34** are already removed from the orifice edges **30** and thus are not affected by the ambient fluid **39** being drawn into the chamber **14**. Meanwhile, a jet of ambient fluid **39** is synthesized by the vortices **34** creating strong entrainment of ambient fluid drawn from large distances away from the orifice **16**.

It is recognized that synthetic jet actuators, such as the actuator set forth above, can be subjected to a range of environment conditions during use. In some instances, it is desired that the synthetic jet actuator be protected from the surrounding environment, so as to be protected from temperature extremes, moisture, and physical forces/impacts from surrounding components. As such, it is desired that the synthetic jet actuator be "packaged" in a housing-type structure, such as a cover positioned over piezoelectric elements in the synthetic jet actuator.

Referring now to FIG. **4**, according to an embodiment of the invention a synthetic jet actuator **50** is shown. The synthetic jet actuator includes a pair of synthetic jet plates **52**, **54**, shown in FIG. **4** as a first plate **52** and an opposing second plate **54** arranged parallel thereto. Attached to at least one of the first and second plates **52**, **54**, or to both of the first and second plates as shown in FIG. **4**, are actuator elements **56**, **58** configured to cause displacement of the plates. In an exemplary embodiment, actuator elements **56**, **58** comprise piezoelectric elements (e.g., piezoelectric disks) that are configured to periodically receive an electric charge from a controller/power source (not shown), and undergo mechanical stress and/or strain responsive to the charge. The stress/strain of piezoelectric elements **56**, **58** causes deflection of first and second plates **52**, **54** such that, for example, a time-harmonic motion or vibration of the plates is achieved. It is recognized that the piezoelectric elements **56**, **58** coupled to the first and second plates **52**, **54**, respectively, can be selectively controlled to cause vibration of one or both of the plates so as to control the volume and velocity of a synthetic jet stream **60** expelled from the synthetic jet actuator **50**.

The first and second plates **52**, **54** and actuator elements **56**, **58** are positioned within an outer housing **62** having a plurality of walls **64** that surround the first and second plates **52**, **54** and define a chamber or volume **66** within the synthetic jet actuator **50**. The outer housing **62** includes therein one or more orifices **68** to place the chamber **66** within outer housing **62** in fluid communication with a surrounding, external environment **70**. As shown in FIG. **4**, a pair of orifices **68** is formed in outer housing **62** to allow for the drawing in and exhaustion of an ambient fluid into and out of the synthetic jet actuator **50**. That is, as set forth above, the piezoelectric elements **56**, **58** coupled to the first and second plates **52**, **54** are selectively controlled to cause vibration of one or both of the plates so as to control the volume and velocity of synthetic jet stream **60** expelled from one or both of the orifices **68**.

As shown in FIG. **4**, the synthetic jet actuator **50** is secured within the housing by way of a mounting device **72**. In the embodiment, mounting device **72** comprises a plurality of point-contact mounts **74** affixed to an internal surface **76** of the housing **62** and extending inwardly therefrom. The point-contact mounts **74** are configured to attach to end surfaces **78** of the first and second plates **52**, **54** so as to secure the plates within outer housing **62** and prevent movement. That is, in one embodiment, point-contact mounts **74** are positioned so as to attach to the short end surfaces **78** of the rectangular shaped first and second plates **52**, **54**. In an exemplary configuration, point-contact holders

74 are configured as V-shaped holders (i.e., chevron-type holders). A pair of V-shaped holders **74** that are linearly aligned in a lengthwise direction **80** of the outer housing **62** are used to secure each of the first and second plates **52**, **54**. As shown in FIG. **4**, a pair of linearly aligned V-shape holders **74** is positioned on each side of the orifice(s) **68** in the outer housing **62** such that first and second plates **52**, **54** can be mounted on opposite sides of the orifice(s) **68**. To provide for a secure engagement between the V-shaped holders **74** and the first and second plates **52**, **54**, short end surfaces **78** of each of the first and second plates **52**, **54** can include therein a V-shaped notch **82** that is configured to interfit with the V-shaped holders **74**. An adhesive **83** can be added between the notch **82** and V-shaped holder **74** to provide for a more secure bonding. Additionally, the adhesive **83** could have a coefficient of thermal expansion (CTE) between that of the material forming the V-shaped holders **74** and the material forming plates **52**, **54**. Alternative to having a notch **82** formed in plates **52**, **54**, it is recognized that an interference fit could be formed between V-shaped holders **74** and end surfaces **78** of the plates **52**, **54** to secure the plates within housing **62**.

Beneficially, V-shaped holders **74** secure first and second plates **52**, **54** within outer housing **62** in a manner that allows for unimpeded performance of the synthetic jet actuator **50**. That is, as the pair of V-shaped holders **74** used to secure first and second plates **52**, **54** are attached to/interfit with short end surfaces **78** of the plates, the V-shaped holders **74** allow for interference-free deflection of the first and second plates **52**, **54**. Additionally, as the V-shaped holders **74** hold the first and second plates **52**, **54** in a "suspended" arrangement in which the plates are spaced apart from the housing **62**, no contact is made between the first and second plates **52**, **54** and the housing **62** during deflection of the plates induced by actuator elements **56**, **58**. This lack of contact between plates **52**, **54** and housing **62** allows the plates to vibrate at their natural frequency and reduce noise generated by the synthetic jet actuator **50**.

Referring now to FIG. **5**, a synthetic jet actuator **84** is shown according to another embodiment of the invention. The synthetic jet actuator **84** includes a first synthetic jet plate **52** and an opposing second synthetic jet plate **54** arranged parallel thereto. Attached to at least one of the first and second plates **52**, **54**, or to both of the first and second plates as shown in FIG. **5**, are actuator elements **56**, **58** configured to cause displacement of the plates. In an exemplary embodiment, actuator elements **56**, **58** comprise piezoelectric elements (e.g., piezoelectric disks) that are configured to periodically receive an electric charge from a controller/power source (not shown), and undergo mechanical stress and/or strain responsive to the charge. The stress/strain of piezoelectric elements **56**, **58** causes deflection of first and second plates **52**, **54** such that, for example, a time-harmonic motion or vibration of the plates is achieved. It is recognized that the piezoelectric elements **56**, **58** coupled to the first and second plates **52**, **54**, respectively, can be selectively controlled to cause vibration of one or both of the plates so as to control the volume and velocity of a synthetic jet stream **60** expelled from the synthetic jet actuator **84**.

The first and second plates **52**, **54** and actuator elements **56**, **58** are positioned within an outer housing **62** having a plurality of walls **64** that surround the first and second plates **52**, **54** and define a chamber or volume **66** within the synthetic jet actuator **84**. The outer housing **62** includes therein one or more orifices **68** to place the chamber **66** within outer housing **62** in fluid communication with a surrounding, external environment **70**. As shown in FIG. **5**, a pair of orifices **68** is formed in outer housing **62** to allow for the drawing in and exhaustion of an ambient fluid into and out of the synthetic jet actuator **84**. That is, as set forth above, the piezoelectric elements **56**, **58** coupled to the first and second plates **52**, **54** are selectively controlled to cause vibration of one or both of the plates so as to control the volume and velocity of synthetic jet stream **60** expelled from one or both of the orifices **68**.

The synthetic jet actuator **84** is secured within the housing **62** by way of a mounting device **86**. In the embodiment of the invention shown in FIG. **5**, mounting device **86** comprises an adhesive **88** applied to opposing internal surfaces **76** of the outer housing **62**. Outward facing surfaces **90** (i.e., back surfaces) of the first and second plates **52**, **54** are pressed onto the adhesive **88** such that the plates are secured within outer housing **62** and prevented from moving. As shown in FIG. **5**, adhesive **88** acts to space first and second plates **52**, **54** apart from the housing **62** in a "suspended" arrangement, such that no contact is made between the first and second plates **52**, **54** and the housing **62** during deflection of the plates induced by actuator elements **56**, **58**, thus allows the plates to vibrate at their natural frequency and reduce noise generated by the synthetic jet actuator **84**. Additionally, adhesive **88** is applied such that it covers only a portion of the back surface **90** of first and second plates **52**, **54** and is formed as a flexible adhesive so as to allow for interference-free deflection of the first and second plates **52**, **54**. While shown as a continuous section of adhesive **88** in FIG. **5**, it is also recognized that the adhesive could be in the form of a post or posts (i.e. discrete attach points vs. a continuous line of adhesive) or other suitable configurations. The exact configuration/shape of the applied adhesive **88** could be determined based on materials, frequency of operation of the synthetic jet actuator, manufacturability, and other factors.

Another embodiment of the invention, is shown in FIG. **6** and shows a synthetic jet actuator **92** having first and second synthetic jet plate **52**, **54** spaced apart by a flexible support structure **93** (i.e., wall or posts). Attached to at least one of the first and second plates **52**, **54**, or to both of the first and second plates as shown in FIG. **6**, are actuator elements **56**, **58** configured to cause displacement of the plates. It is recognized that the actuator elements **56**, **58** coupled to the first and second plates **52**, **54**, respectively, can be selectively controlled to cause vibration of one or both of the plates so as to control the volume and velocity of a synthetic jet stream **60** expelled from the synthetic jet actuator **92**.

The first and second plates **52**, **54** and actuator elements **56**, **58** are positioned within an outer housing **94** that surrounds the first and second plates **52**, **54** and define a chamber or volume **66** within the synthetic jet actuator **92**. The outer housing **94** includes a pair of V-shaped walls **96** on opposing sides thereof and one or more orifices **68** to place the chamber **66** within outer housing **94** in fluid communication with a surrounding, external environment **70**. The synthetic jet actuator **92** is secured within the housing **94** by way of cradles **98** that form a mounting device. Cradles **98** are mounted to an inner surface **100** of the V-shaped walls **96** such that they contact the first and second plates **52**, **54**. The V-shaped walls **96** allow for the structure formed by first and second plates **52**, **54** and support structure **93** to be wedged between the V-shaped walls **96** and supported thereby in a point-contact fashion. This point-contact between plates **52**, **54** and housing **94** allows the plates to vibrate at their natural frequency and reduce noise generated by the synthetic jet actuator **92**.

As set forth above with respect to FIGS. **4-6**, a minimal-contact mounting arrangement of the first and second synthetic jet plates **52**, **54** within an outer housing **62**, **94** is provided. The housing **62**, **94** of synthetic jet actuator **50**, **84** provides protection from the surrounding environment **70**, such that synthetic jet actuator **50**, **84**, **92** is protected from temperature extremes, moisture, and physical forces/impact from surrounding components. Additionally, the embodiments set forth above provide for a mounting structure of synthetic jet plates **52**, **54** within outer housing **62**, **94** that has a minimal impact on performance of the synthetic jet actuator **50**, **84**, as the suspension mounting arrangement prevents outer housing **62**, **94** from interfering with the deflection and vibration of the plates **52**, **54** of the synthetic jet actuator.

While the synthetic jet actuators of FIGS. **4-6** are shown/described as having multiple orifices therein forming separate intake and exhaust orifices, it is also envisioned that embodiments of the invention could be used with single orifice synthetic jet actuators. Additionally, while the synthetic jet actuators of FIGS. **4-6** are shown/described as having an actuator element included on each of first and second plates, it is also envisioned that embodiments of the invention could include only a single actuator element positioned on one of the plates. Furthermore, it is also envisioned that the synthetic jet actuators set forth above could be circular/cylindrical in shape and that the synthetic jet plates and actuator elements therein be circular in shape and mount to the housing in one of the manners set forth above, rather than in a rectangular configuration.

While the invention has been described in detail in connection with only a limited number of embodiments, it should be readily understood that the invention is not limited to such disclosed embodiments. Rather, the invention can be modified to incorporate any number of variations, alterations, substitutions or equivalent arrangements not heretofore described, but which are commensurate with the spirit and scope of the invention. Additionally, while various embodiments of the invention have been described, it is to be understood that aspects of the invention may include only some of the described embodiments. Accordingly, the invention is not to be seen as limited by the foregoing description, but is only limited by the scope of the appended claims.

Therefore, according to one embodiment of the invention, a synthetic jet actuator includes a first plate, a second plate spaced apart from the first plate and arranged parallelly thereto, and a housing positioned about the first and second plates and defining a chamber, the housing having at least one orifice therein such that the chamber is in fluid communication with an external environment. The synthetic jet actuator also includes a mounting mechanism configured to mount the first and second plates within the housing in a suspended arrangement and an actuator element coupled to at least one of the first and second plates to selectively cause deflection thereof, thereby changing a volume within the chamber so that a series of fluid vortices are generated and projected to the external environment out from the at least one orifice of the housing.

According to another embodiment of the invention, a method of manufacturing a synthetic jet actuator includes providing an outer housing having a plurality of walls defining a chamber and having an orifice formed in at least one of the plurality of walls and positioning a pair of synthetic jet plates within the outer housing and on opposite ends thereof. The method also includes attaching the pair of synthetic jet plates to the outer housing such that the pair of synthetic jet plates are spaced apart from each of the plurality of walls.

According to yet another embodiment of the invention, a synthetic jet actuator includes an outer housing defining a chamber and having at least one opening formed therein and a pair of synthetic jet plates positioned within the outer housing and on opposing sides thereof. The synthetic jet actuator also includes a mounting device configured to affix the pair of synthetic jet plates to the outer housing such that the pair of synthetic jet plates are inwardly spaced from the outer housing so as not to be in contact therewith and at least one actuator element coupled to the pair of synthetic jet plates to selectively change a volume within the chamber so that a series of fluid vortices are generated and projected to an external environment out from the at least one opening in the outer housing.

What is claimed as new and desired to be protected by Letters Patent of the United States is:

1. A synthetic jet actuator comprising:
- a first plate;
- a second plate spaced apart from the first plate;
- a housing positioned about the first and second plates and defining a chamber, the housing having at least one orifice formed in a side surface of the housing such that the chamber is in fluid communication with an external environment;
- a set of cradles mounted at opposing ends of the housing and configured to receive the first and second plates so as to space the first and second plates from the housing;
- an actuator element coupled to at least one of the first and second plates to selectively cause deflection thereof to project fluid from the at least one orifice of the housing; and
- a pair of flexible support structures extending between the first and second plates so as to space the first and second plates apart;
- wherein the pair of flexible support structures comprises:
  - a first flexible support structure coupled to a first end of the first plate and a first end of the second plate; and
  - a second flexible support structure coupled to a second end of the first plate and a second end of the second plate.

2. The synthetic jet actuator of claim **1** wherein the housing comprises a pair of V-shaped walls on opposing ends of the housing.

3. The synthetic jet actuator of claim **2** wherein the set of cradles are mounted to an inner surface of the pair of V-shaped walls.

4. The synthetic jet actuator of claim **1** wherein the at least one orifice comprises a pair of orifices and the set of cradles are further configured to mount the first and second plates within the housing on opposing sides of the pair of orifices.

5. The synthetic jet actuator of claim **1** wherein the set of cradles is configured to mount the first and second plates within the housing such that the first and second plates are spaced apart from the housing in a suspended arrangement and such that no contact is made between the first and second plates and the housing.

6. The synthetic jet actuator of claim **1** wherein the actuator element coupled to at least one of the first and second plates comprises a pair of piezoelectric elements, and wherein each piezoelectric element is attached to a respective plate of the first and second plates to selectively cause deflection thereof.

7. The synthetic jet actuator of claim **1** wherein no contact is made between the first and second plates and the housing during deflection of the plates induced by the at least one actuator element.

8. A method of manufacturing a synthetic jet comprising:
- providing a housing defining a chamber and having at least one orifice formed within the housing such that the chamber is in fluid communication with an external environment;
- mounting a pair of cradles on opposing ends of the housing to form a mounting device;
- securing a first synthetic jet plate and a second synthetic jet plate to the pair of cradles within the housing such that the first and second synthetic jet plates are spaced apart from the housing;
- coupling an actuator element to at least one of the first and second synthetic jet plates to selectively cause deflection thereof, so that fluid is projected to the external environment out from the at least one orifice of the housing; and
- coupling a pair of flexible support structures to the first and second synthetic jet plates, the pair of flexible support structures disposed between the first and second synthetic jet plates and configured to space the first and second synthetic jet plates apart;
- wherein coupling the pair of flexible support structures comprises:
  - coupling a first flexible support structure to a first end of the first synthetic jet plate and a first end of the second synthetic jet plate; and
  - coupling a second flexible support structure to a second end of the first synthetic jet plate and a second end of the second synthetic jet plate.

9. The method of claim **8** wherein coupling an actuator element comprises attaching one of a pair of piezoelectric elements to the first synthetic jet plate and the other of the pair of piezoelectric elements to the second synthetic jet plate to selectively cause deflection of the first and second synthetic jet plates.

10. The method of claim **8** wherein positioning a housing comprises positioning a housing including a pair of V-shaped walls on opposing ends of the housing.

11. The method of claim **10** wherein mounting a pair of cradles on opposing ends of the housing comprises mounting the pair of cradles on an interior surface of the V-shaped walls.

12. The method of claim **10** wherein securing the first and second synthetic jet plates comprises wedging the first and second synthetic jet plates, which are separated by the pair of flexible support structures, into the pair of cradles and between the V-shaped walls, such that the first and second synthetic jet plates are mounted in a point-contact fashion.

13. A synthetic jet actuator comprising:
- a housing defining a chamber and having at least one opening formed therein;
- a first synthetic jet plate and a second synthetic jet plate positioned within the housing and on opposing sides thereof;
- a mounting device configured to secure the first and second synthetic jet plates within the outer housing such that the first and second synthetic jet plates are inwardly spaced from the outer housing so as not to be in contact therewith;
- at least one actuator element coupled to the first and second synthetic jet plates to selectively cause deflection thereof, so that fluid is projected to an external environment out from the at least one opening in the outer housing;
- a first flexible support structure coupled to a first end of the first synthetic jet plate and a first end of the second synthetic jet plate; and
- a second flexible support structure coupled to a second end of the first synthetic jet plate and a second end of the second synthetic jet plate;
- wherein the mounting device comprises a pair of cradles attached to opposing ends of the housing, each of the pair of cradles configured to support a respective plate of the first and second synthetic jet plates to secure the plates within the outer housing in a point-contact fashion; and
- wherein the first and second flexible support structures are positioned between the first synthetic jet plate and the second synthetic jet plate to space the first synthetic jet plate apart from the second synthetic jet plate.

14. The synthetic jet actuator of claim **13** wherein the housing comprises a pair of V-shaped walls on opposing ends of the housing, and wherein the pair of cradles are attached to an inner surface of the pair of V-shaped walls.

15. The synthetic jet actuator of claim **13** wherein the set of cradles are configured to mount the first and seconds synthetic jet plates on opposing sides of the at least one orifice.

16. The synthetic jet actuator of claim **13** wherein no contact is made between the first and second plates and the housing during deflection of the plates induced by the at least one actuator element.

17. The synthetic jet actuator of claim **13** wherein the at least one actuator element comprises a pair of piezoelectric elements, and wherein each piezoelectric element is attached to a respective synthetic jet plate of the first and second synthetic jet plates to selectively cause deflection thereof.

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